JANUARY 1964
Valid from Serial no. 116.350

Parts-List

and

Trouble Shooting

High Speed Level Recorder

Type 2305

Brüel & Kjær

DENMARK

BH 2305

A. FAULT TRACING

A. 1. Hum (beat at 50 or 60 c/s). Faulty V2-V3. Replace. Power transformer mounting screws possibly loosened. Tighten and adjust according to item B. 8 in the "Checking and Adjustment" section.

A. 2. Beat at 5 kc/s may appear after replacement of tubes or components. Adjust according to item B. 7.

A. 3. Beat at 2.5 kc/s normally disappears when adjustment is carried out as per item B. 7. in the "Checking and Adjustment" section. If not, this indicates an unbalance in the signal rectifier, e.g. an error in Q1-4. All four diodes should then be replaced.

A. 4. Overswing may be due to defects in Q1-4 (see above), incorrectly balanced V9-V10 (adjust according to item B. 2) or misalignment of the output amplifier (adjust according to item B. 4). Overswing may also be caused by incorrect or defective contacts in the pen drive system (magnet system, see "C. Mechanical Maintenance").

A. 5. Too low resolving power may be due to mechanical friction (see item B. 12), unbalance in the output amplifier (item B. 4) or too low amplification of the output amplifier (the latter is due to a defective component which should be found and replaced). Too low resolving power may also be caused by short-circuited windings in the pen drive coil (item B. 1). Adjust according to item B. 9.

A. 6. Incorrect writing speed may be due to a defect in the feedback coil of the pen drive system (normal resistance of coil approximately 1ooo Ω), fault in the limiting diodes Q12-Q13, or unbalance in the output amplifier (item B. 4).

A. 7. Non-linear frequency response (input potentiometer and input attenuator on maximum sensitivity). Normally due to faulty input amplifier. Check the sensitivity. If normal, the tube voltages should be measured and the defective component (tube) found and replaced. Readjust according to item B. 10.

A. 8. Faulty relays may be due to a blown fuse V15. Remove back cover, the fuse is located underneath the mains transformer. Check rectifiers Q25-26.

A. 9. Pen Drive System Contact Defects. See "C. Mechanical Maintenance".

B. ELECTRONIC SECTION, CHECKING AND ADJUSTMENT

B.1. Tube Voltages. Firstly the bottom plate is removed, and the resistance in the drive coil from B- to chassis is measured by means of an ohmmeter, this should read 2000—2500 Ω. The apparatus is then set to the correct mains voltage, switched on and started. The "Pot. Range" switch is placed on "Stand by". After approximately 5 min. the voltages of the tube sockets are measured and compared with those stated on the diagram.

B.2. Balance of the Input Amplifier. After being driven for ten minutes the anode voltage of V9—V10 is measured at points C and D. The two voltages should be the same within approximately 10 V. If not, readjust by potentiometer P1, marked "DC balance".

B.3. Chopper Voltage. The 5 kc/s voltage to the chopper is measured between the points E and F. It should be 5.5—8 Volt.

B.4. Balance of the Output Amplifier. The "Pot. Range" switch is set to "Stand by". Measure between B+ and B—. Voltage should be approximately 5 Volt. Then measure between B— and chassis. Voltage should be 0. (Tolerance ± 10 Volt).

If unbalanced, adjust as follows: The grid of V6 is grounded at H. With a tube voltmeter measure the 5 kc/s voltage across the primary of T3 and adjust P13 ("5 kc/s compensation") to give minimum voltage. Then adjust the balance of the output stage: With a d.c. voltmeter measure the voltage B+ B— across R1 and the voltage B— to chassis and adjust P4—P5 to give 5 volts and 0 volts, respectively. Finally balance the chopper: remove the grounding of the grid of V6, and adjust P7, "chopper balance", to give 0 to 6 volts between B— and Chassis. (Drive coil to pull slightly against the zero on the paper scale).

B.5. Drive Power Check. The "Pot. Range" switch is turned to a position corresponding to the potentiometer used. Across the drive coil, from B— to chassis a voltage of 135 to 180 Volt should be measured with no input signal to the Recorder. (With a very high input signal, i.e. an input signal higher than that which makes the recording pen deflect to maximum, a voltage of —135 to —180 should be measured).

B. 6. Writing Speed. The applied signal voltage should be great enough to give full deflection of the writing sapphire while using 50 mm wax paper. The paper is then kept running while the signal voltage is intermittently removed. The slope of the lines thus produced is the ratio between the paper speed and the writing speed. If the writing speed has to be adjusted, proceed as follows:—
With the "Writing Speed" knob in position "8 mm/sec" (large figures) the P3 "Velocity Adjustment" potentiometer is adjusted, until the speed is correct. By turning the potentiometer clockwise a decrease in speed is obtained. Next place the knob in position "1000 mm/sec" and adjust P12 "Max. Velocity Adjustment" until correct speed (1ooo mm/sec) is obtained. Turning the potentiometer clockwise will give an increased writing speed.

B.7. 5 kc/s Beat. If a beat signal is found to be present due to the measurement of an input signal with a frequency close to 5 kc/s, P8 "5 kc/s Beat" is adjusted until the beat disappears.

B.8. Hum. If a beat with a signal frequency close to mains frequency is present, P9 and P14 "Hum Compensation" are adjusted until the beat is eliminated.

B.9. Resolving Power. Should a larger or smaller resolution than the one adjusted at the factory be required, this can be obtained by means of P10, "Resolution". A too large resolution will cause overswing and unstability. A clockwise turn will give a smaller degree of resolving ability.

B.10. Frequency Response. After replacement of tubes or other components it may be necessary to adjust the frequency response at 150—200 kc/s. P11 ("Input Potentiometer") is set to position 10 and P6 marked "Frequency Characteristic" adjusted. With the "Rectifier Response" switch in position "RMS" adjustment is made in such a way that a decrease of o.2—o.5 db at 200 kc/s will result. By aligning in a manner that the response increases at 200 kc/s some instability might be introduced.

B.11. Sensitivity and Reference Voltage. A considerable change in the original zero level is a sign of incorrectly operating input amplifier or rectifier. When this is corrected the reference voltage is checked as follows. The recorder is set to "RMS" and a lower limiting frequency of 20 c/s. A voltage of 100 mV at any frequency between 50 and 10ooo c/s is applied to the Recorder input and the deflection of the writing pen is noted.

By pressing the "100 mV Ref." button the deflection should remain unchanged. If this is not the case, adjust the reference voltage with P2 "100 mV Ref.".

B.12. Mechanical Friction. The total friction of the writing system as a whole is readily checked as follows. The recorder is set to 50 mm writing width, wax paper applied and the lowest writing speed selected, and a DC voltmeter is connected between B— and chassis (i.e. across the drive coil). A signal is then applied making the sapphire draw a straight line across the paper. As long as the system continues to move, the voltage should be 10—20 Volts. If a higher reading results the magnet system and the writing arm should be cleaned as described below.

C. MECHANICAL MAINTENANCE

C.1. The Magnet System. The drive coil is joined to two brass tubes which slide on teflon covered steel bars. After considerable wear some teflon dust will appear. This dust may settle on the contact tracks of the system and periodically cause faulty contact. Probable symptoms are, irregular writing speed, overswing and tendency towards fluctuation. The dust can be removed by means of a smooth brush. The contact track of the potentiometer arm is accessible when the potentiometer is removed. The four contact tracks of the drive coil are placed in a housing below a cover which can be seen when the potentiometer is withdrawn. This can easily be removed by unscrewing the five visible locating screws. For the cleaning of the contact tracks and the contact points a soft cloth damped with benzine is sufficient. *Under no circumstances should oil be applied to the magnet system.* The silver lamellae on the potentiometer are also cleaned with benzine, and any metallic dust between the lamellae removed with a brush. After considerable wear it may be desirable to re-grind the potentiometer arm. This is done by placing a piece of the very finest obtainable glass-paper beneath the silver lamellae and by raising the three legs of the potentiometer a corresponding or greater height by the insertion of paper washers. The potentiometer is then inserted and the writing system moved to and fro several times. The potentiometer is then removed and the edges of the moving arm are carefully ground by means of a piece of glass-paper. Glass-paper and paper washers are now removed from the potentiometer, the grinding-dust carefully blown off, and the potentiometer re-inserted.

The writing system is carefully moved forwards and backwards two or three times before the apparatus is commenced to operate. It should be noted that normal contact pressure is 15 grammes.

C.2. Writing Arm. Dust disapated from wax paper and similar pollution may increase the friction between the guides and the sliding bars. Cleaning is carried out by means of triclorethylene. *Under no circumstances must the writing arm be oiled.*

C.3. Gear Box. After long usage it may be found necessary to clean and oil the gear box. Tto do this, firstly remove the writing arm as described under C4 (Bottom-Plate Cleaning 1—2—3—4). The four retaining screws of the stainless steel plate on which the paper runs are now visible. These are also removed and the plate taken off, thus making the major components of the gear box accessible.

Clean with benzine and lubricate the following parts with a non-acidic machine oil (e.g. sewing machine oil):—

(a) Worm and worm drive
(b) All metal drive wheels
(c) Toothed sector and associated gear lever
(d) Moving parts for 1 : 10 gear-shift.

The following parts are **not** oiled:—

Axle bearings (self-lubricating)
Motor-bearings (self-lubricating)
Magnetic clutch
Gear-shift lifting toggles
Nylon wheels
Pen-lifting and marking relays.

The friction coupling on the axle for the paper drive can be tightened if necessary, and a little thin oil may be applied.

Output bushings for flexible shafts: Check that the axles are not obstructed when the lid with the bushings is tightened. The flexible drive may be oiled.

C.4. Paper Drive Unit.

Catching and Tearing of the Paper. Although properly adjusted prior to despatch, occasions may arise after transit or a period of use when the paper tends to catch and thus tear at the perforations. The main factors

contributing to this are incorrect tensioning of the Paper Drive Clip and to lesser degree fouling under the Bottom Plate of the Writing Arm Unit by wax or other particles, especially on the head of the countersunk fixing screws.

Remedial Action.

Adjustment of Paper Guide Clip

1. Lift stylus by means of Mechanical Lifting Arm A (Fig. 1) to prevent damage to stylus or plate.
2. Remove paper.
3. Set Synchronizing Gear Lever "X" to "in" position.
4. Set "Paper Speed" to "100 mm/sec".
5. Place "Motor Drive" on "Start" and adjust the Paper Guide Clip E so that its lips just touch the rims of the Paper Drive Sprocket by turning screw K (Fig. 1). This condition is checked by listening for the initial point of contact. At or near this point the Paper Guide Clip pressure is suitable tensioned for smooth pull-off of paper from roll.

   (N.B. Screwdriver must be removed for each trial to avoid excess pressure on clip).

Bottom-Plate Cleaning.

1. Disconnect Recorder power supply.
2. Remove Writing Arm Unit Cover by pulling cover to the right.
3. Release Driving Arm from Writing Arm bogey as described in the Instruction Manual for Type 2305.
4. With screwdriver withdraw the holding screws as shown in Fig. 1 and carefully lift off complete unit.
5. With soft cloth and trichlorethylene remove any wax or waste matter from Recorder Writing Plate. Finally polish.
6. Apply the same method as in 5 to cleaning of Bottom Plate.
7. Pull out Polar Recording pin and place in hole P (Fig. 1).
8. Replace Writing Arm Unit and set so that the distance to pin P is 0.5 mm, thus ensuring that unit is accurately and squarely situated.

10. Firmly hold in this position and tighten down holding screws.
11. Reset Driving Arm in Writing Arm Bogey as described in Instruction Manual for Type 2305, item Alteration of Writing Width.
12. Replace Writing Arm cover and check setting of Paper Guide Clip as described under "Adjustment of Paper Guide Clip".

PARTS-LIST 2305

Component Type		Stock Reference	Circuit-diagram Reference
Power cord, EUR plug		AN 0005	
Power cord, USA plug		AN 0006	
Condensers:			
Electrolytic	2 × 32 μF/500 V	CE 2245	C 1-2
»	8 μF/ 25 V	CE 3535	C 3-5
»	50 μF/450 V	CE 0901	C 6-7
»	25 μF/ 50 V	CE 8948	C 8
» non polarized	2 μF/100 V	CE 8927	C 9
» » »	12 μF/ 50 V	CE 8959	C 10
» » »	50 μF/ 50 V	CE 0505	C 66
Ceramic	50 pF ± 10 %	CK 0004	C 12-13
»	70 pF ± 5 %	CK 0025	C 11, 58-59
»	1 pF ± o.25 pF	CK 0031	C 14, 57
»	5 pF ± 10 %	CK 0034	C 17
»	2.5 pF ± 5 %	CK 0104	C 16
»	10 pF ± 10 %	CK 0036	C 15
»	15 pF ± 10 %	CK 0037	C 18
»	20 pF ± 10 %	CK 0038	C 20
»	50 pF ± 5 %	CK 0058	C 21
»	390 pF — 20 + 50 %	CK 0084	C 22
»	1 nF — 20 + 50 %	CK 0085	C 23
»	4,7 nF ± 20 %	CK 0087	C 24-29
»	65 pF ± 5 %	CK 0100	C 56
»	29 pF ± 5 %	CK 0105	C 19
Paper ± 5 %	15 nF/400 V	CP 5963	C 30
	1.5 μF/250 V	CP 8590	C 63
Mylar	47 nF/250 V	CS 0009	C 31-32, 45-46, 53, 55
»	o.1 μF/250 V	CS 0013	C 35-36
»	o.33 μF/250 V	CS 0019	C 37-38
»	o.68 μF/250 V	CS 0023	C 39-41, 67
»	22 nF/400 V	CS 0105	C 42-44
»	47 nF/400 V	CS 0109	C 47-48
»	3 × 2 μF/250 V	CS 0028	C 49, 51
»	o.47 μF/250 V	CS 0021	C 33-34
Polystyrene ± 5 %,	150 pF/125 V	CT 0105	C 54
» »	200 pF/500 V	CT 0107	C 65
»	210 pF ± 2.5 %	CT 0231	C 64
Miscellaneous:			
Panel lamp housing		DB 0338	
Polar recording pin		DB 0340	
Bakelite foot for cabinet		DF 7000	

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Component Type	Stock Reference	Circuit-diagram Reference
Nylon gear wheel 22-22 f. 50 c/s	DG 0233	
Nylon gear wheel 20-24 f. 60 c/s	DG 0232, DG 0234	
Event marker pen	DH 2000	
Recording pen	DH 2001	
Event marker stylus	DH 2002	
Recording stylus	DH 2003	
Paper cutter	GV 0183	
Coaxial input socket	JJ 0014	
2-channel input socket	JJ 4700	
Remote control socket	JJ 4705	
Panel lamp socket	JO 0001	
Coaxial input plug	JP 0018	
2-channel input plug	JP 4701	
Remote control input plug 6-p	JP 4705	
Remote control input plug 7-p	JP 4707	
Power voltage selector	JS 0001	O 6
Fuse socket, 24 V system	JS 0007	
Mahogany cabinet	KA 2305	
Mahogany case for potentiometer	KE 0005	
Steel cabinet	KQ 2305	
Choke	LJ 0003	L 1
On-Off switch	NN 0563	N 1-2
Forward-reverse switch	NN 0564	N 3
Start-stop switch	NN 0567	N 4
Microswitch for gear box	NT 0004	N 8-10
Microswitch for reference	NT 0011	N 5
Single chart push-button	NT 1774	N 6
Event marker push-button	NT 1775	N 7
Power input socket	OA 0008	
DC - AC signal chopper	OC 0269	Z 1
Cam disc, 180°	OD 0059	
Cam disc, short pulse	OD 0060	
Cam disc, 90°	OD 0061	
Input attenuator switch	OX 2305	O 1
Writing speed switch	OS 2305	O 2
Lower lim. frequency switch	OT 2305	O 3
Rectifier response switch	OU 2305	O 4
Potentiometer range switch	OV 2305	O 5
Carbon potentiometer 200 Ω	PG 1201	P 1
» » 10 kΩ	PG 3102	P 2
» » 50 kΩ	PG 3501	P 3-5
» » 100 kΩ	PG 4102	P 6
» » 150 kΩ	PG 4151	P 13
» » 500 kΩ	PG 4501	P 7, 10
» » 1 MΩ	PG 5102	P 12, 14
Wire-wound 50 kΩ	PV 3507	P 11

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Component Type			Stock Reference	Circuit-diagram Reference
Silicon point-contact diode			QV 0022	Q 1-4
Germanium point-contact diode			QV 0078	Q 5-6
Germanium point-contact diode			QV 0085	Q 7-10
Silicon junction diode			QV 0202	Q 12-17
Silicon junction diode			QV 0209	Q 18-21
Silicon power rectifier			QV 0300	Q 24-26
Silicon zener diode			QV 1106	Q 27-28
Silicon power rectifier			QV 0023	Q 11, 22-23, 29-35
Silicon zener diode			QV 1005	Q 36
Resistors:				
Carbon film	1 W		RK 200 Ω	R 1, 2
»	1 W	5 %	RK 63 kΩ	R 3, 4
»	½ W		RK 1.25 kΩ	R 5
»	½ W		RK 2 kΩ	R 6
»	½ W	5 %	RK 10 kΩ	R 7
»	½ W	5 %	RK 12.5 kΩ	R 8
»	½ W	5 %	RK 20 kΩ	R 9
»	½ W	5 %	RK 31.5 kΩ	R 10, 11
»	½ W	5 %	RK 63 kΩ	R 12, 13
»	½ W	5 %	RK 125 kΩ	R 14, 15
»	½ W		RK 160 kΩ	R 16
»	½ W		RK 200 kΩ	R 17
»	½ W		RK 500 kΩ	R 18
»	½ W		RK 10 MΩ	R 19
»	½ W	2 %	RK 630 Ω	R 20-22
»	½ W	2 %	RK 800 Ω	R 23
»	½ W	2 %	RK 1.6 kΩ	R 24-25
»	½ W	2 %	RK 25 kΩ	R 26
»	½ W	2 %	RK 50 kΩ	R 27
»	½ W	2 %	RK 100 kΩ	R 28-31
»	½ W	2 %	RK 2×2.5 MΩ	R 32
»	½ W	2 %	RK 1.25 MΩ	R 33, 34
»	½ W		RK 10 kΩ	R 50
»	⅓ W		RK 500 Ω	R 40
»	⅓ W		RK 1 kΩ	R 41, 42
»	⅓ W		RK 2 kΩ	R 43-45
»	⅓ W		RK 10 kΩ	R 46-48, 51-52
»	⅓ W		RK 12.5 kΩ	R 49
»	⅓ W		RK 80 kΩ	R 53-56
»	⅓ W		RK 100 kΩ	R 57, 58
»	⅓ W		RK 200 kΩ	R 59
»	⅛ W	2 %	RK 250 kΩ	R 60, 61
»	⅛ W		RK 315 kΩ	R 62, 63

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Component Type			Stock Reference			Circuit-diagram Reference
Resistors cont.:						
Carbon film	1/3 W		RK	500	kΩ	R 64-66
»	1/3 W		RK	1	MΩ	R 67
»	1/3 W		RK	1.6	MΩ	R 68
»	1/3 W		RK	4	MΩ	R 69
»	1/3 W	2 %	RK	1.4	kΩ	R 70, 71
»	1/3 W	2 %	RK	1.9	kΩ	R 72, 73
»	1/3 W	2 %	RK	2.1	kΩ	R 74, 75
»	1/3 W	2 %	RK	2.9	kΩ	R 76, 77
»	1/3 W	2 %	RK	4	kΩ	R 78, 79
»	1/3 W	2 %	RK	5	kΩ	R 80-83
»	1/3 W	2 %	RK	6.3	kΩ	R 84, 85
»	1/3 W	2 %	RK	9	kΩ	R 86, 87
»	1/3 W	2 %	RK	12.5	kΩ	R 88, 89
»	1/3 W	2 %	RK	3.15	kΩ	R 90
»	1/3 W	2 %	RK	10.5	kΩ	R 91
»	1/3 W	2 %	RK	25	kΩ	R 92
»	1/3 W	2 %	RK	42	kΩ	R 93
»	1/3 W	2 %	RK	75	kΩ	R 94
»	1/3 W	2 %	RK	120	kΩ	R 95
»	1/3 W	2 %	RK	200	kΩ	R 96
»	1/3 W	2 %	RK	350	kΩ	R 97
»	1/3 W	2 %	RK	400	kΩ	R 98
»	1/3 W	2 %	RK	500	kΩ	R 99
»	1/3 W	2 %	RK	630	kΩ	R 100
»	1/3 W	2 %	RK	850	kΩ	R 101
»	1/3 W	2 %	RK	1.6	MΩ	R 102
»	1/3 W	5 %	RK	2	MΩ	R 103
»	1/3 W	2 %	RK	3.5	MΩ	R 104
»	1/2 W	0.5 %	RK	17.09	kΩ	R 35
»	1/2 W	0.5 %	RK	22.5	kΩ	R 36
»	1/2 W	0.5 %	RK	24.21	kΩ	R 37
»	1/2 W	0.5 %	RK	24.75	kΩ	R 38
»	1/2 W	0.5 %	RK	24.92	kΩ	R 39
»	1/3 W	1 %	RK	4.1	kΩ	R 105, 106
»	1/3 W	1 %	RK	15.3	kΩ	R 107, 108
»	1/3 W	1 %	RK	30.0	kΩ	R 109, 110
»	1/3 W	1 %	RK	34.6	kΩ	R 111, 112
»	1/3 W	1 %	RK	40.0	kΩ	R 113, 114
»	1/3 W	1 %	RK	42.0	kΩ	R 115, 116
»	1/3 W	1 %	RK	50.0	kΩ	R 117, 118
»	1/3 W	1 %	RK	62.0	kΩ	R 119, 120
»	1/3 W	1 %	RK	109.0	kΩ	R 121, 122
»	1/3 W	0.5 %	RK	25.05	Ω	R 123
»	1/3 W	0.5 %	RK	54.28	Ω	R 124
»	1/3 W	0.5 %	RK	252.5	Ω	R 125

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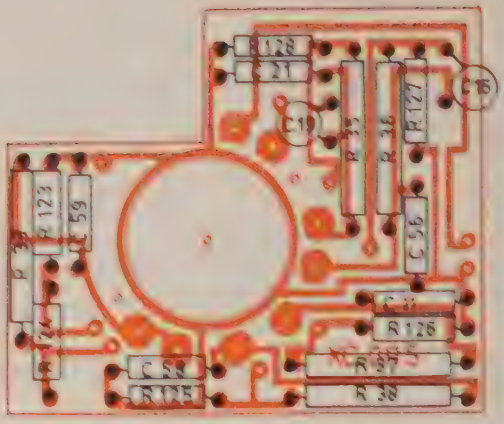
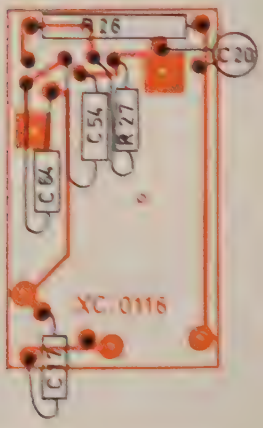
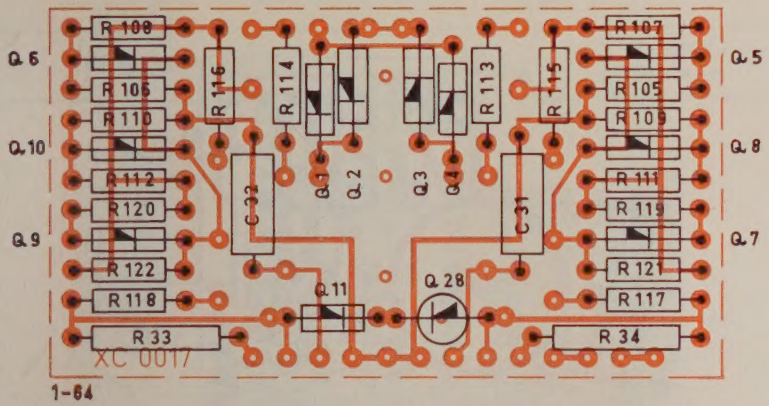
Component Type			Stock Reference	Circuit-diagram Reference
Resistors cont.:				
Carbon film	⅓ W	0.5 %	RK 816 Ω	R 126
»	⅓ W	0.5 %	RK 2.78 kΩ	R 127
»	⅓ W	0.5 %	RK 11.56 kΩ	R 128
»	⅓ W		RK 10 MΩ	R 129
Wire wound	5.5 W	15 kΩ	RX 0304	R 130, 131
»	5.5 W	390 Ω	RX 0301	R 132
»	8 W	6.8 kΩ	RX 0401	R 134, 135
»	8 W	10 kΩ	RX 0403	R 136
»	8 W	1.8 kΩ	RX 0400	R 137
NTC	1.8 W	15 kΩ	RN 0003	R 138
Miscellaneous:				
Bakelite knob			SN 0807	
Bakelite knob (gear shift)			SN 0812	
Power transformer			TN 9820	T 1
Oscillator transformer			TO 8344	T 2
Output transformer			TU 8209	T 3
Writing system (complete)			UA 2000	
Paper guide and roll retainer			UA 2001	
Gear box complete with motor			UG 0085	
Motor			UM 0029	
Pen lifting and event marker unit			UM 0500	
Magnetic drive system			UM 2305	
Tubes:				
Triode-pentode 6U8 (ECF 82)			VA 0014	V 1
Pentode 6AU6 (EF 94)			VA 0021	V 4-6
Power pentode 6BQ5 (EL 84)			VA 0023	V 7-8
Power pentode 6DL5 (EL 95)			VA 0026	V 9, 10
Voltage stabilizer OA 2			VA 0037	V 12, 13
Pentode 6AU6 (EF 94)			VA 0070	V 2, 3
Fuse 1.6 A - 250 V			VF 0007	V 14-15
Panel lamp 6.3 V - 0.3 A			VS 8024	V 16
Printed wiring, rect. response			XC 0017	
Printed wiring, amplifier			XC 0180	
Printed wiring, writing speed			XC 0049	
» » potentiometer range			XC 0050	
» » lower lim. frequency			XC 0172	
» » input attenuator			XC 0115	
» » input potentiometer			XC 0116	



INPUT ATTENUATOR



INPUT POTENTIOMETER



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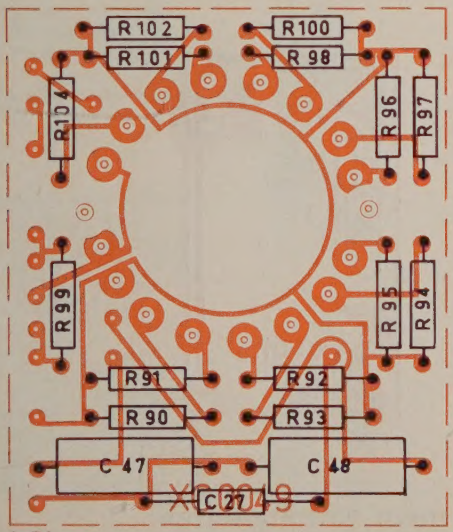
RECTIFIER RESPONSE



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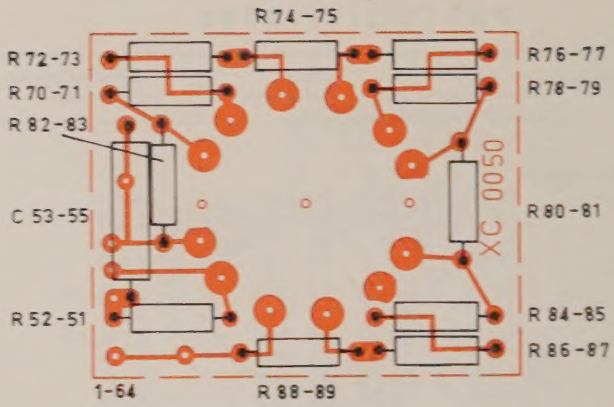
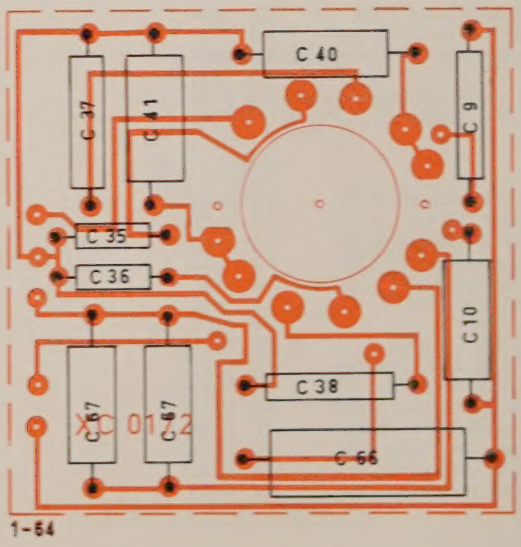
WRITING SPEED

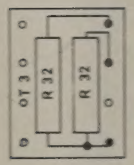


POTENTIOMETER RANGE



LOWER LIMITING FREQUENCY

T 2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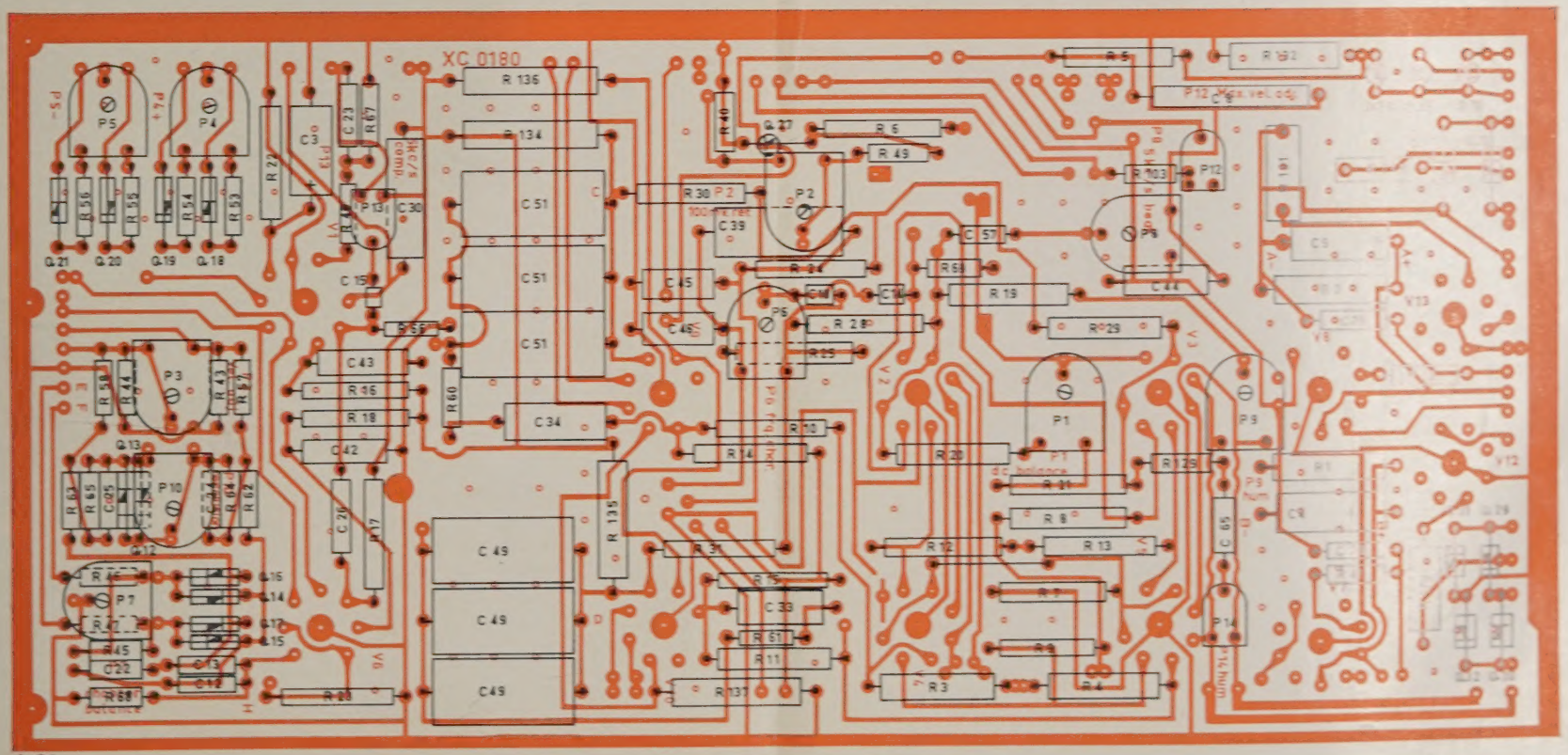
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